MDA Horticulture Fund Fiscal Year 2005 Final Report

Title: *Assessing the degradation of biopolymer pots for the nursery and transplant production and landscaping industry*

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Project justification/statement of challenge leading to project

Each year the nursery/landscape, greenhouse, vegetable industries and end users discard millions of non-degradable pots with which plants were grown. This creates a waste disposal problem that is detrimental to the environment and is costly in landfill fees.

The development of biodegradable pots that degrade over a specified time period under specific conditions (and also maintain its integrity and performance throughout the season) would eliminate the need to remove the pots at the end of the growing season. Furthermore biodegradable pots will avoid transplanting damages of plants, thus reducing transplant stress.

Objectives

This proposal is part of a major proposal being funded by project GREEEN and supported the first stage of this major project. The specific objectives of this proposal were consisted: 1) in the developing of the methodology to test the degradability of biopolymers in soil that could be used into other equivalent projects and (2) the identification of the biopolymer to be used in the pots

Accomplishment

An automatic direct measurement respirometric (DMR) system (Figure 1) was built, calibrated and tested to determine polymer biodegradation under simulated environmental conditions. The amount of carbon dioxide produced during polymer biodegradation was converted to percentage of mineralization, and used as an indicator of the polymer biodegradation. This DMR system consists of 7 main components: (1) carbon dioxide gas scrubber, (2) relative humidity generator, (3) environmental chamber, (4) bioreactors (Figure 2), (5) electronic manifold valves and switching system, (6) measurement devices, and (7) control software. According to ASTM D 5338 and ISO 14855, this DMR has capability of testing 23 bioreactors (which equal to 17 samples of biodegradable polymers plus 3 bioreactors for blank compost and 3 bioreactors for positive control materials) at the same time. Number of bioreactors in DMR is very

critical, because an incubation period for each experiment ranges from 45-180 days; therefore, the DMR should be able to test as many samples as possible.

In February 2006, The DMR was used to determine the biodegradability of poly(lactide) (PLA) bottles. This experiment was designed to verify that this instrument could be used to measure the biodegradability of polymer. The PLA bottles were used as test material, poly(ethylene terephthalate) (PET) bottles as negative control material, and corn starch powder as positive control material. The DMR was set to operate under compost environment (58°C and 50-60%RH) and all the materials were exposed to mature yard compost. The experiment was carried out for 63 days and the percentage of biodegradation (% mineralization) of PLA, corn starch, and PET was 64.2±0.5%, 72.4±0.7%, and 2.7±0.2% mineralization, respectively (Figure 3). Based on the ASTM D 5338 and ISO 14855, it was confirmed that PLA was really biodegradable. **.** A complete description of the system can be found at: "*Development of an Automatic Laboratory-Scale Respirometric System to Measure Polymer Biodegradability*," Kijchavengkul, T.; Auras, R.; Rubino, M.; Ngouajio, M.; Fernandez, T. Polymer Testing; Forthcoming 2006

Future and current studies

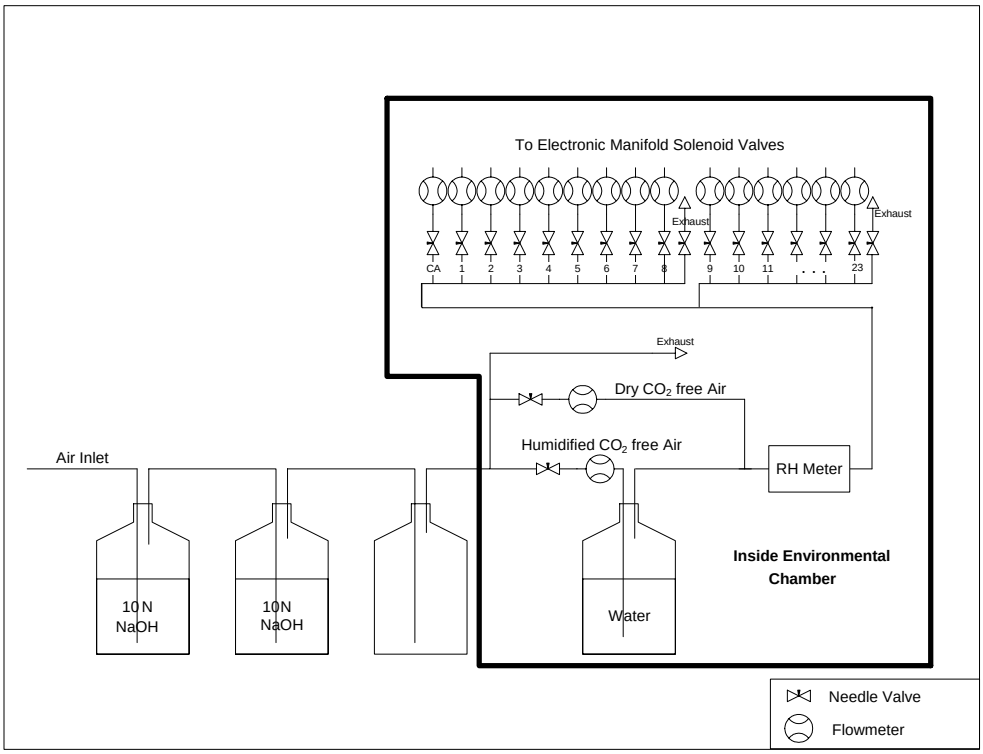
The application of the biodegradable film will be considered for mulch film initially and then will be applied into the pots.

Initially field studies are been conducted this year from June-September 2006 in mulch film. Three biodegradable Ecoflex® films (from Northern Technologies International) will be placed over tomato fields along with a conventional polyethylene mulch film. Any changes in mechanical, physical, and optical properties due to degradation will be observed and determined. Every 2 weeks the film samples will be taken out and characterized. Tensile properties, molecular weight, glass transition temperature, melting temperature, % crystallinity, % light transmission and color changes will be measures as a function of time. Some properties of these films at day 0 were shown in Table 1.

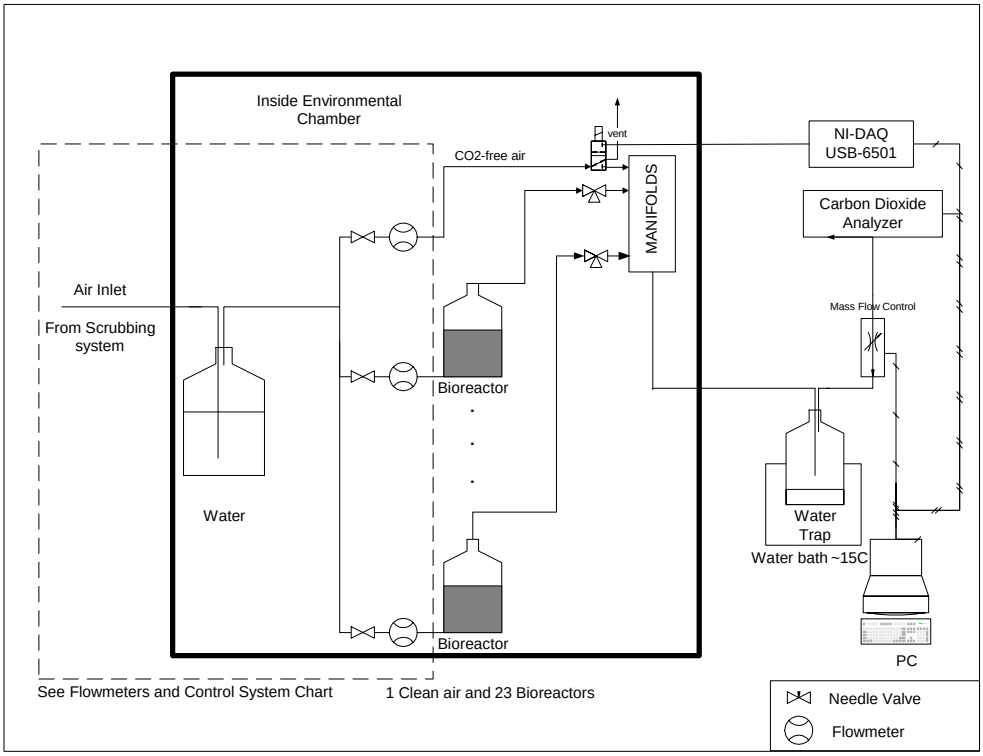
Table 1

Film	Tensile strength (ksi) MD/CD	% Elongation MD/CD	% Light transmission	Mn	Mw	PI
25 microns	2.44±0.81/ 2.16/0.33	488±28/ 499±40	92.55±0.38	60112±2878	86395±2221	1.438±0.033
30 microns	1.82±0.13/ 1.40±0.10	414±44/ 324±86	93.02±0.61	61035±1837	86576±1106	1.419±0.025
35 microns	2.28±0.25/ 1.84/0.13	520±51/ 527±21	93.87±0.69	61587±2403	89316±1946	1.451±0.026

The results regarding biodegradability and material integrity will be used as a based to develop the biodegradable pots.



(a)



(b)

Figure 1. Schematic drawing of direct measurement respirometric system; a) Flowmeters and humidity control; b) Respirometric system components

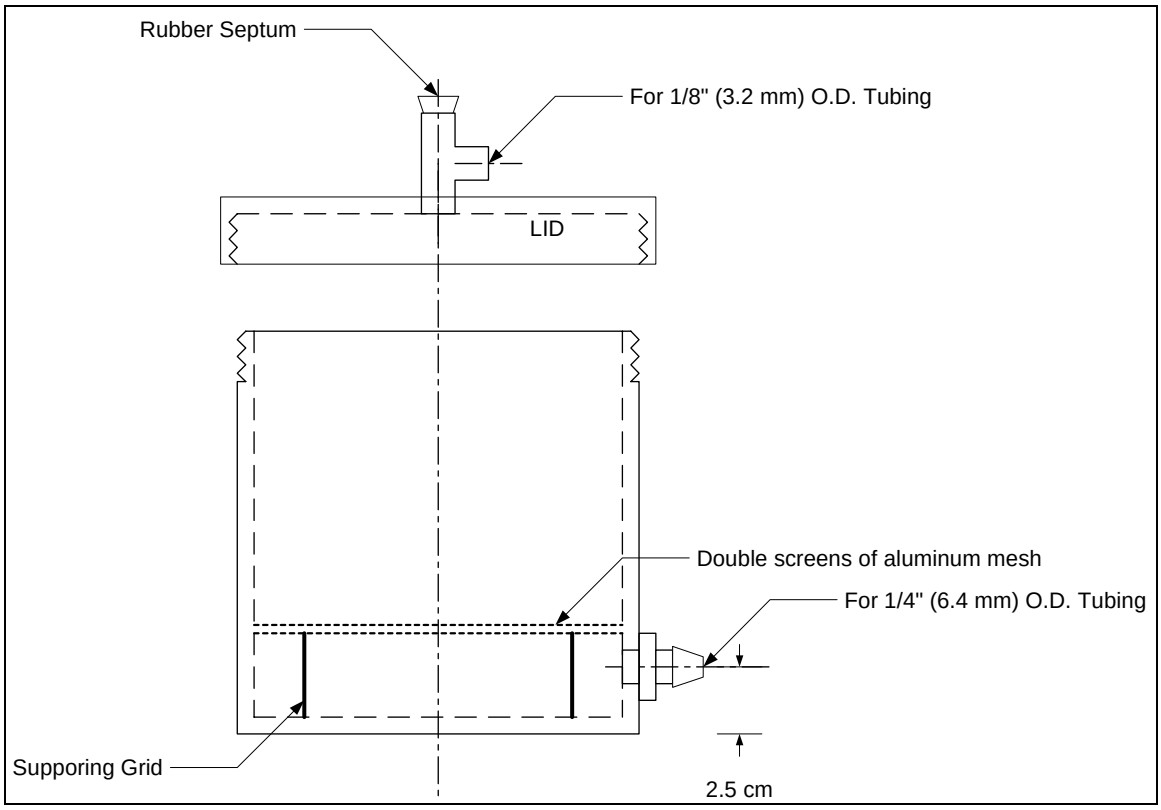


Figure 2. Drawing of bioreactor

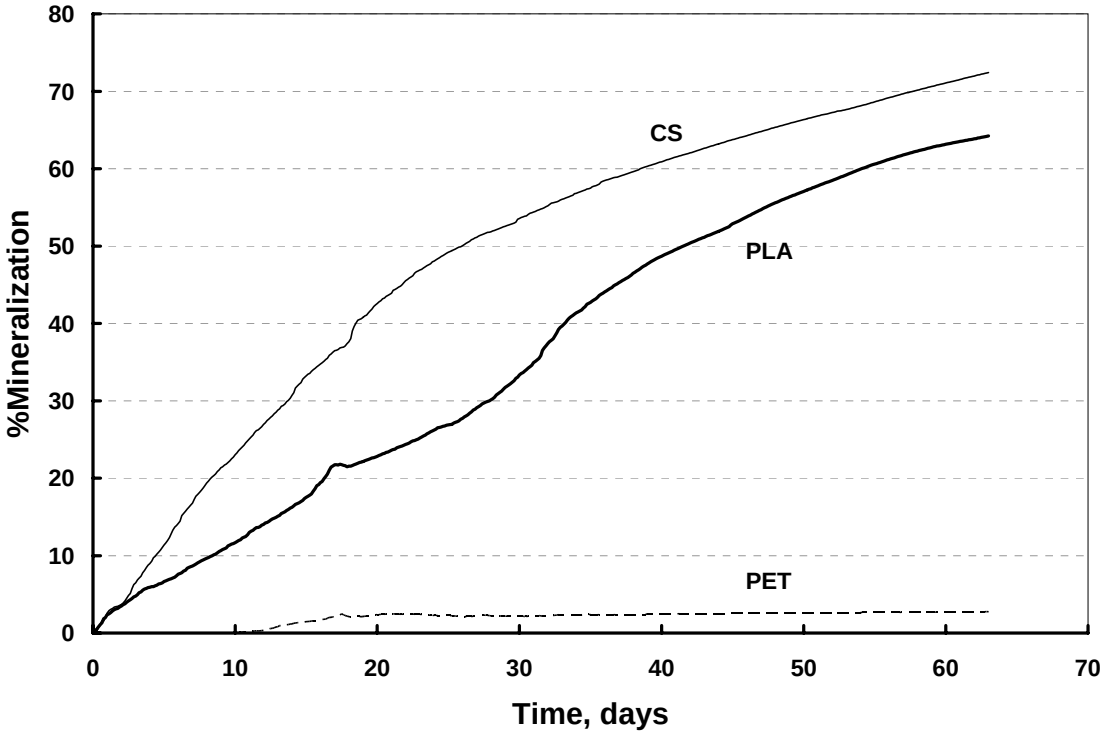


Figure 3. Percentage of mineralization of PLA, PET, and corn starch at 58±2°C and approximately 55±5% RH in yard waste compost